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03 obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity with a water concentration calibration curve prepared in advance.

REMARKS

The Office Action of June 3, 2002 has been received and its contents carefully considered.

The Examiner indicates that none of the certified copies of the priority documents have been received.

The certified copies of the priority documents were filed in this application on May 10, 2001. Applicants request the Examiner to acknowledge receipt of the certified copies of the priority documents.

The Examiner has not acknowledged the Information Disclosure Statements and Forms PTO-1449 that were filed on May 10, 2001 and July 25, 2002. Applicants request the Examiner to make such an acknowledgement and to return to applicants an initialed and dated copy of these Forms.

The Examiner has made of record the telephone restriction requirement and applicants' election of the invention of Group I, claims 1-10 and 13-16. The Examiner states that applicants must affirm this election when responding to the Office Action. Applicants hereby affirm the election.

Claims 13-21 have been objected to as being improper multiple dependent claims because they depend on other multiple dependent claims.

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In response, applicants have amended claims 13 and 14 to make them dependent on claim 1 only.

Claims 1, 2 and 4-10 have been rejected under 35 U.S.C. § 102(b) as anticipated by the 1998 Wu et al article in Analytic Chemistry.

Applicants submit that Wu et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

The present invention, in one aspect as set forth in claim 1, is directed to a method for measuring a water concentration in ammonia, comprising (a) introducing a gaseous phase moiety of liquefied ammonia having a water concentration of 10 ppm or less as a reference gas into a multi-reflection long optical path cell, (b) measuring infrared absorption intensity at an infrared wave number at which infrared absorptions of ammonia and water do not overlap as background absorption, (c) introducing the ammonia as a sample at a constant flow rate into the cell, (d) measuring infrared absorption intensity of water at the infrared wave number, and (e) obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity with a water concentration calibration curve prepared in advance.

Thus, applicants have amended claim 1 to set forth the steps of the present invention in more detail. See pages 11 to 14 of the specification. Claim 1 recites that two measurements are made, one of the reference gas to provide a background absorption intensity and the other of a sample whose water concentration is to be measured, and states that both measurements employ an infrared wave number. Claim 1 further states that gaseous phase moiety of liquefied ammonia is employed as the reference gas.

In another aspect, and as set forth in new claim 22, the present invention provides a method for measuring a water concentration in ammonia having a water concentration of 10 ppm or less, comprising (a) introducing a gaseous phase moiety of liquefied ammonia as a reference gas into a multi-reflection long optical path cell, (b) measuring infrared absorption intensity at an infrared wave number at which infrared absorbances of ammonia and water do not overlap as background absorption, (c) introducing a gas vaporized by heating liquefied ammonia as a sample at a constant flow rate into the cell, (d) measuring infrared absorption intensity of water at the infrared wave number, and (e) obtaining the water concentration based on the measured intensity of the sample and the background absorption intensity with a water concentration calibration curve prepared in advance.

Wu et al disclose a method for measuring trace moisture in ammonia, wherein a “near-infrared” wavelength is employed. The wavelength described in Wu et al is 1371nm (page 3316, right column, lines 6-8) corresponding to a wave number 7294cm^{-1} . See also, page 3317, left column, where Wu et al describe the use of a “near-infrared” InGaAsP DFB laser emitting at 1371nm. On the other hand, the present invention, as set forth in claims 1 and 22, measures “infrared absorption intensity”, not “near-infrared” absorption intensity. Thus, “an infrared wave number” is employed in the present invention and wavelengths used in the present invention fall within the infrared region (2,500 to 50,500nm, corresponding to a wave number 200 to $4,000\text{cm}^{-1}$), which are quite different from the wavelength used in Wu et al.

The Examiner relies on the disclosure at page 3316 of Wu et al, where it is disclosed that two H_2O absorption lines at 1923.162 and 1922.342cm^{-1} were employed in a prior art technique, at which the absorbance of NH_3 molecules was relatively small. See page 3316, left column,

lines 20-22. However, as the present inventors mention in the “Background Art” at section page 3 of the present specification, measuring methods using a wave number wherein the ammonia and water absorbances do not overlap had been known to those skilled in the art at the time of completion of the present invention. The present invention is to solve a problem remaining in conventional methods that results because trace moisture quantitative analysis has a large margin of error.

The Wu et al disclosure at page 3316, left column, does not disclose a measuring of a reference gas and a measuring of a sample and does not disclose that the reference gas is a gaseous phase moiety of liquefied ammonia. Accordingly, this disclosure of Wu et al does not anticipate the presently claimed invention.

The infrared spectrometry method for measuring a water concentration in ammonia described in the present invention requires an ammonia gas containing a negligible water content as a reference gas, while the Wu et al article describes using a specific wavelength only, but does not describe using such a reference gas at all. The present invention, which can solve problems in conventional infrared spectrometry methods, was not anticipated by the Wu et al reference describing the use of wavelengths near the wavelength used in the present invention and/or use of similar measurement cells.

The Examiner relies on the disclosure at page 3320, under the heading “Calibration of H₂O in NH₃”, which, according to the Examiner, discloses the use of reference gases containing, respectively, 110ppb, 245ppb, 523ppb water content. However, the gases used in Wu et al are quite different from the reference gas used in the present invention. In Wu et al, the three gases having different water contents are used for establishing a calibration curve. Also, in the

measuring method of the present invention, gases having a certain water content similarly are used for producing a calibration curve, but are not employed as a “reference gas”. The present invention uses a reference gas (an ammonia gas containing a negligible water content) in order to refer to the minute amount of moisture contained in the ammonia gas as a background measurement at the wavelength.

Moreover, the Wu et al measurements with the gases containing 110, 245 and 523 ppb of H₂O were made with a laser wavelength of “1370.93 to 1370.99nm”, as disclosed at page 3320, left-column, lines 15 to 17, which as discussed above is a “near-infrared” wavelength, and is quite different from the infrared absorption intensity that is measured in the present invention.

Moreover, the method of Wu et al obtains absorption spectra of 110, 245 and 523ppb water in NH₃ by adding water vapor to “pure NH₃” passed through a purifier. However, it is not clear whether the moisture in the ammonia gas in Wu et al is sufficiently removed by the purifier since the water concentration within the trace moisture measurement region cannot be determined at all. Since Wu et al do not teach measuring the concentration of water in the “pure NH₃” obtained through a purifier, the zero point in the Wu et al calibration curve is not determined. Therefore, it is clear that values in the Wu et al curve purportedly calibrated by adding water at a certain concentration contain noise, and such a method can only obtain results with low reproducibility.

The present invention is based on the present inventors’ finding, described at pages 11 and 12 of the present specification, that the water concentration distributed to the gaseous phase of the liquefied ammonia is as low as a range of from one-tenth to one-hundredth of the water concentration in the liquid phase, and as described in the present specification, the present

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invention can use as a reference gas the gaseous phase of liquefied ammonia whose slight water content in the liquid phase falls within the measurable range detectable by a known method. Use of such a reference gas is not described by Wu et al at all. The present claims recite the use of the gaseous phase of liquefied ammonia, and are not disclosed or suggested by Wu et al.

The Examiner also refers to the description in the "CONCLUSIONS" section at page 3321 of Wu et al. Although there is no detailed description in the "CONCLUSIONS" section, this section of Wu et al discloses using a wavelength of 1371nm (wave number 7294cm^{-1}), which as discussed above is a near-infrared wavelength and which is different from the wavelengths employed in the present invention.

In view of the above, applicants submit that Wu et al do not disclose or render obvious the presently claimed invention and, accordingly, request withdrawal of this rejection.

Claims 3-5 have been rejected under 35 U.S.C. § 103(a) as obvious over the 1998 Wu et al article in Analytic Chemistry.

Applicants submit that these documents do not disclose or render obvious the subject matter of claims 3 and 4 and, accordingly, request withdrawal of this rejection.

The Examiner recognizes that Wu et al do not disclose the wave numbers recited in claims 3 and 4, and does not disclose vaporizing liquefied ammonia to obtain ammonia as recited in claim 5. The Examiner argues that it would have been obvious to find other IR ranges and use them in the process of Wu et al where the water absorption signals would not overlap with the ammonia absorption signal. The Examiner also argues that it would have been obvious to vaporize liquefied ammonia to obtain ammonia gas because ammonia is transported and stored in liquefied form.

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Claims 3 and 4 depend from claim 1. Accordingly, applicants submit that these claims are patentable for the same reasons as discussed above in connection with claim 1.

Further, with respect to the Examiner's argument that it would have been obvious to find other IR ranges, applicants point out that Wu et al disclose at page 3319, right hand column, that the balance that they were able to obtain in order to carry out the method disclosed in this Wu et al article could not be easily achieved due to various factors. Applicants submit that, in view of the difficulty that is referred to by Wu et al, it would not have been obvious that one could have found other IR ranges and successfully employed them.

In addition, and as discussed above, there is a wide overlap between ammonia and water absorbances, and it is impossible to obtain accurate results by only selecting a wavelength at which the absorbances do not overlap. In order to conduct accurate and reproducible measurement by an infrared spectrometry method, it is necessary to use as a reference gas an ammonia gas having a negligible water content, which Wu et al neither teach nor suggest.

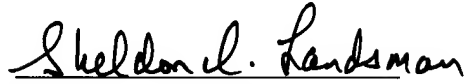
In view of the above, applicants submit that claims 3 and 4 are patentable over Wu et al and, accordingly, request withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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APPENDIX
VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

The claims are amended as follows:

1. (Amended) A method for measuring a water concentration in ammonia, comprising:

introducing a gaseous phase moiety of liquefied ~~using ammonia~~ having a water concentration of 10 ppm or less as a reference gas, ~~introducing the ammonia at a constant flow rate into a multi-reflection long optical path cell,~~

and measuring infrared absorption intensity at an infrared ~~of water at a wave number at~~ which infrared absorptions of ammonia and water do not overlap as background absorption,

introducing the ammonia as a sample at a constant flow rate into the cell,

measuring infrared absorption intensity of water at the infrared wave number, and

obtaining the water concentration based on the measured intensity of the sample and the

background absorption intensity with a water concentration calibration curve prepared in

advance.
13. (Amended) A method for producing ammonia having a decreased water content, wherein the method comprises the steps of distilling crude ammonia and measuring a water concentration in ammonia using a measurement method as claimed in ~~any one of claims 1 to 10~~ claim 1.
14. (Amended) A method for producing ammonia having a decreased water content, wherein the method comprises the steps of purifying crude ammonia by contacting it with at

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least one purifying agent selected from the group consisting of metals, metal oxides and zeolite
and measuring a water concentration in ammonia using a measurement method as claimed in any
~~one of claims 1 to 10~~claim 1.

Claim 22 has been added as a new claim.